**SECTION 26 32 13.16**

**ENGINE-DRIVEN GENERATOR SETS - NATURAL GAS [LP]**

**BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/23**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

**PART 1 - GENERAL**

**SCOPE**

***The consultant shall provide a brief description of the packaged engine generator system specified on this project including but not limited to size, voltage, fuel type, cooling method, indoor/outdoor installation, etc.***

***Units sized 500KW/ 625KVA and below shall have option of utilizing Natural gas as fuel. Discuss with DFD electrical staff use of natural gas units. Does not include health care facilities.***

***Units serving remote facilities, sized 150KW/ 187.5KVA and below shall have option of utilizing LP as fuel. Discuss with DFD electrical staff use of LP units. Does not include health care facilities.***

***Units utilizing LP fuel shallhave fuel storage tank sized based on 20 degree F sizing tables. Discuss with DFD electrical staff resulting de-rating size requirements.***

***Coordinate fuel piping and associated costs with agency and site. Typical extension of piped natural gas shall be by local supplier and provided by separate contract through this project.***

The work under this section includes providing a complete factory assembled packaged engine generator system with controls and startup testing. Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference Standards

Permits

Submittals

Operation and Maintenance Data

Quality Assurance

Extra Materials

PART 2 - PRODUCTS

System Ratings

Engine and Engine Equipment

Alternator

Over Current Protective Device

Accessories

PART 3 - EXECUTION

Examination

Installation

Field Quality Control

Construction Verification Items

Functional Performance Testing

Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this section.

Section 23 24 00 - Internal Combustion Engine Piping

Section 26 05 73 - Short Circuit/ Coordination Study and Arc Flash Risk Assessment

Section 26 36 00 - Transfer Switches

Section 26 08 00 - Commissioning of Electrical

Section 01 91 01 or 01 91 02 – Commissioning Process

**REFERENCE STANDARDS**

NFPA 101 - Life Safety Code

NFPA110 – Emergency and Standby Power Systems

ANSI/NEMA MG 1 - Motors and Generators

UL2200 – Stationary Engine Generator Assemblies

**PERMITS**

The Contractor shall be responsible for obtaining all necessary permits for the complete installation of the generator fuel system and related equipment.

**SUBMITTALS**

Submit shop drawings showing detailed equipment assemblies and indicate dimensions, weights, loads, required clearances, plan and elevation views with overall location and interconnection point dimensions, method of field assembly, components and location and size of each field connection.

Include product data for generator and all accessories: batteries and charger, engine generator set, muffler, exhaust piping external to unit, outdoor enclosure, remote annunciator(s), remote emergency stop, load center and lighting integral to enclosure, cooling system heaters. In addition, fuel consumption rate curves at various loads, ventilation and combustion air requirements, thermal damage curves for generator, time current characteristic curves for generator protective device (if included) and electrical ratings and diagrams including schematic and interconnection diagrams.

Certified Test Reports. Factory test reports including noise level, exhaust emissions, and field quality tests.

Certification of Torsional Vibration Compatibility.

Documentation for a 1 year comprehensive engine, parts, and enclosure warranty.

Wiring diagram for status of generator output circuit breaker(s) or OCPD serving the emergency side of each automatic transfer switch. Include annunciation and indication monitoring integral to annunciator panel. Submit manufacturer's installation instructions.

Provide verification of coordination for Emergency and Legally Required Standby systems overcurrent devices with all supply side overcurrent protective devices.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**QUALITY ASSURANCE**

Manufacturer: Company specializing in packaged engine generator systems with minimum ten years documented experience. Packaged generator assembly shall meet UL 2200 requirements.

Supplier: Authorized distributor of engine generator manufacturer with service facilities within 100 miles of project site.

**EXTRA MATERIAL**

Provide two additional sets of each fuel, oil, and air filter elements required for the engine generator system and one additional set of all required belts.

**PART 2-PRODUCTS**

**SYSTEM RATINGS**

Generator Set Rating: [ ] kW, [ ] kVA, 0.8pf, [208/120] [480/277] VAC, 3 phase, 4 wire, 12 wire re-connectable, 60 Hz. Standby power rated.

***The consultant shall review the following paragraph and specify the motor starting kVA from typical model data sheets. Units serving fire pumps shall not have a voltage drop greater than 15%.***

Motor starting KVA shall be [ ] kVA based on a sustained RMS voltage drop of no more than [35%][15% ] of no load voltage with the specified kVA load at near zero power factor applied to the engine-generator set. Units serving fire pumps shall not have Voltage drops at less than 15%.

The generator set manufacturer shall verify the engine as capable of driving the generator with all accessories in place and operating at the nameplate rating after de-rating for the range of temperature expected in service and the altitude of the installation.

The engine-generator set shall be capable of picking up 100% of nameplate kW, less applicable de-rating factors, in one step with the engine-generator set at operating temperature.

Voltage regulation shall be ±1.0% of rated voltage for any constant load between no load and rated load. Random voltage variation with any steady state load from no load to full load shall not exceed ±1.0% of rated voltage.

Frequency regulation shall be ±0.5% from steady state no load to steady state rated load.

Harmonic distortion shall not exceed 5% total harmonic distortion at full linear load and no single harmonic shall exceed 3% of rated voltage.

Telephone Influence Factor: TIF shall be less than 50.

**ENGINE AND ENGINE EQUIPMENT**

**Engine Type**: Water-cooled, [turbo-charged] [normally aspirated], four cycle, internal combustion engine.

**Fuel Type**: [Natural Gas] [LP]

**Governor**: Isochronous electronic type to maintain engine speed within 0.5 percent, steady state, and 1 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.

**Safety Devices**: Engine shutdown on high water temperature, low oil pressure, over-speed, and engine over-crank. Limits as selected by manufacturer.

**Engine Accessories**: Include intake air filter, fuel filter, fuel priming pump, automatic electric fuel shutoff, fuel/water separator, gear-driven water pump, positive displacement mechanical full pressure lubrication oil pump, full flow lubrication oil filters with replaceable elements, dipstick oil level indicator, and oil drain valve with hose extension. Include engine mounted battery charging alternator with solid state voltage regulator.

**Engine Jacket Heater**: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C). Heater voltage shall be served from integral Branch Circuit Panelboard.

The consultant shall determine the type of cooling system required for the application and edit the following paragraph accordingly.

**Cooling System**: Unit mounted radiator using glycol coolant, with blower type fan, coolant pump and thermostat temperature control sized to maintain safe engine temperature in ambient temperature of 105 degrees F. Radiator shall be provided all ductwork required with a duct adapter flange permitting the attachment of air discharge duct directing the discharge of radiator air to exterior louver location.. The equipment supplier shall provide 50% ethylene glycol antifreeze solution to fill engine cooling system.

***EC shall edit exhaust system narrative to match the project requirements. The installation of the exhaust system piping for interior installed units or units with piping extending beyond the generator enclosure shall be done under Division 23. The consultant shall coordinate the requirements with the Division 23 consultant. Provide details indicating routing, length and number of elbows for exhaust piping. Dimensions of piping shall be included in narrative.***

**Exhaust System:** Provide critical grade silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. The muffler shall be mounted so its weight is not supported by the engine.

Flexible exhaust connections shall be provided as required for connection between engine exhaust manifold and exhaust line, in compliance with applicable codes and regulations.

Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine. Provide drain line to drip pan.

Provide a suitable rain cap at the stack outlet. Provide all necessary flanges and special fittings for proper installation.

***The exhaust piping insulation shall be done under Division 23. The consultant shall coordinate the requirements with the Division 23 consultant. Note: Verify engine exhaust temperature with suppliers. Several manufacturers are indicating exhaust temperatures of 1380 F which exceeds the standard insulation rating of 1200 F. Insulation rating of 1700 F may be required.***

The Division 23 Contractor shall mount and install all exhaust components as shown on drawings and as required to comply with applicable codes and regulations. All components shall be properly sized to assure proper operation without excessive back pressure when installed as shown on the drawings. Make provisions as required for pipe expansion and contraction.

***The installation of the fuel system shall be done under Division 23. The consultant shall coordinate the requirements with the Division 23 consultant.***

**Fuel System**: Provide fuel lockout solenoid and fuel regulator, based on manufacturers operating pressure, between 7”-14” H2O.

Provide flexible supply and return line fittings and all connections for connecting fuel system to the engine in compliance with applicable codes and regulations. All fuel piping shall be pressure tested for minimum 2 hours. Primary regulator and flexible fuel hose with stainless steel over-braid shall be provided by the generator supplier.

Coordinate with local utility gas provider for new gas service and associated regulator. Piping shall be compliant with utility company installation requirements and NFPA 110. Provide a gas meter and regulator for the generator service. Meter and regulator serving generator shall be separate from the building’s gas service and shall be connected on the supply side of the main gas shutoff valve to allow for emergency response team to shut off building gas service without shutting of generator gas service

Provide separate identifying labeling and tags at shutoff valves indicating an emergency generator and main building per NFPA 110.

**Batteries**: Heavy duty, diesel starting type, lead-acid storage batteries. Provide a DC 12 volt system with number of batteries and battery capacity as sized by the manufacturer adequate for (4) 30 second cranking periods (total of 2 minutes) along with all additional loads being run on the DC system. Battery submittals shall include type, amp-hour rating and cold cranking amps.

**Mounting:** Provide unit with suitable spring-type vibration isolators and mount on structural steel base.

**ALTERNATOR**

Insulation: ANSI/NEMA MG 1, Class H.

Alternator Speed: 1,800 rpm

The unit shall be single bearing, self-aligning 4-pole, brushless, synchronous type, revolving field windings, and direct driven centrifugal blower for proper cooling and minimum noise. No brushes will be allowed.

The unit shall be 3-phase, broad-range, re-connectable and shall have 12 leads brought out to allow connection by user to obtain any of the available voltages for the unit. Leads shall terminate in NEMA 1 connection enclosure. A fully rated, isolated neutral connection shall be included by manufacturer.

The alternator shall meet temperature rise standards of UL2200 (120 degrees C). The insulation system material shall be class “H”.

The regulator design shall include torque-matching characteristics to allow the engine to use its fullest power producing capacity (without exceeding it or over compensating) at speeds lower than rated, to optimize motor starting capability and provide the fastest possible recovery from transient speed dips. Regulators which use a fixed volt per hertz characteristic are not acceptable.

The alternator shall include a permanent magnet generator (PMG) exciter and electronic voltage regulator, and shall be self-ventilated drip-proof construction built in accordance with NEMA, AIEE and ANSI standards.

The alternator shall be protected against overloads and short circuits by electronic control panel protective functions. Functions shall be implemented electronically in the control panel. The generator design shall be of the self-protecting type as demonstrated by the prototype short circuit test. Systems utilizing 3-wire, solid state control elements rotating in the rotor, will not be acceptable.

***The consultant shall specify the connection enclosure, type and size of output lug and the size of the circuit breakers(s). Consultant shall review with DFD staff if circuit breaker(s) are required and type. If closed transition transfer switches are utilized, circuit breaker shall be electronic type, 100% rated, provided with a shunt trip.***

**OVER CURRENT PROTECTIVE DEVICE**

[No circuit breaker required: Provide a NEMA 1 connection cabinet, factory wired line side, field connectable load side, sufficiently sized for 125% of generator nameplate rating. Bus shall be pre-drilled for two-hole cable connectors. Generator shall be provided with Overcurrent Protection per NEC Article 445.12]

[Circuit breaker required: Provide a mainline molded case circuit breaker(s), 100% electronic,

[ Amp], on generator output with adjustable long time and short time delay and instantaneous trip; complying with NEMA AB 1 and UL489. Trip settings shall be factory set to generator thermal damage curve.]

[Include battery-voltage operated shunt trip, connection to open circuit breaker(s) when generator is shut down by internal or external protective devices.]

[Provide an additional set of load side lugs on the generator output bus to serve a remote load bank.]

**ACCESSORIES**

Provide the following accessories with the engine generator set.

The following paragraph applies to outdoor installations. The consultant shall delete the following for indoor installations.

Silencer: Outdoor enclosure mounted: Critical grade, minimum 30 dB reduction. Silencer shall be located inside enclosure.

The following paragraph applies to indoor installations. The consultant shall delete the following for outdoor installations.

Silencer: Indoor mounted: Critical grade, Minimum 30 dB reduction. Units installed indoors shall be pancake style (hockey puck). Support independently to structure.

The following paragraph applies to outdoor installations. The consultant shall delete the following for indoor applications.

**Enclosure**: Weather protective housing with the following features: Skin Type.

Vandal-resistant

[Galvanized steel body] [Aluminum body]

Lifting points on base frame

Stainless steel flush fitting latches and hinges

Stainless steel fasteners

Sheet steel components pre-treated with zinc phosphate prior to polyester powder coating

Multiple lockable panels/doors on each side installed to allow access to components requiring maintenance

Radiator fill access door with lockable cover

Engine cooling via airflow through enclosure

Lube oil and coolant drains piped to the exterior of the enclosure skid base

Battery can only be reached through lockable doors

Air discharge to be [horizontal] [vertical] from radiator. [Vertical air discharge to mix with engine exhaust to assist in exhaust dispersion.]

Sound attenuation housing to limit noise level not to exceed 75dB at 23 feet @ rated output.

**Load Center - Enclosure**: Integral load center [60/2] [100/3] amps to serve accessories including, but not limited to, the battery charger, engine heater, enclosure lighting, and convenience receptacle. Panelboard and all associated accessory circuitry shall be field installed by the Electrical Contractor.

Load center style panelboard: plug-on circuit breaker type, fully rated, Type 3R enclosure, 3-3/4” D, 14.25” W, code gauge steel, surface mounted with ground bar and lock kit. Copper bus, minimum system (i.e. individual component) short circuit rating: 10,000A. Provide with typed circuit identification directory label. Load center shall be independently supported to equipment pad or unit frame on frame side of engine isolation to avoid load center vibration. Panelboard and all associated accessory circuitry shall be field installed by the Electrical Contractor.

**Electrical Devices - Enclosure**: GFCI WP receptacle. Devices and associated circuitry shall be field installed by the Electrical Contractor.

**Electrical Lighting - Enclosure**: Manual switch inside access door and LED lighting fixture(s). Lighting fixture, switch and associated circuitry shall be field installed by the Electrical Contractor.

**Battery Tray**: Plastic coated metal tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.

**Battery Charger**: A 10-ampere voltage regulated battery charger shall be provided for the engine-generator set. Charger shall be equipped with float, taper and equalize charge settings. Charger shall include overload protection, voltage surge suppressor, DC voltmeter and fused AC input. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30 VDC for remote indication of:

Loss of AC power - red light (no relay contact)

Low battery voltage - red light

High battery voltage - red light (no relay contact)

Charger fail - red light

**Engine-Generator Digital Control Panel - Unit mounted**: Provide a control panel with the top not more than six (6) feet above finished floor (this may require remote mounting). NFPA – 110, NEMA Type 1 generator mounted control panel enclosure with engine and generator controls and indicators containing the following:

***The consultant shall review the requirements of NFPA 110.***

Automatic remote start capability

“Run-Off-Auto” switch

Shut downs as required by NFPA 110 5.6.5.2(3)

Alarms as required by NFPA 110 5.6.5.2(4)

Individual alarm indication as required by NFPA 110.5.6.5.2(4) and table 5.6.5.2

Controls as required by NFPA 110 5.6.5.2(5)

Include remote starting control circuit, with RUN-OFF-AUTO selector switch on engine generator control panel.

Fuel pressure, water temperature, and lube oil pressure shall be monitored by the engine-generator controller.

The control shall include surge suppression for protection of solid state components. A front control panel illumination lamp with On/Off switch shall be provided. The engine-generator set starting batteries shall power the monitor.

**Auxiliary Relay**: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.

**Remote Alarm Contacts**: Pre-wire form C contacts to terminal strip for remote alarm functions required by ANSI/NFPA 110.

**Remote Mounted Annunciator Panel[s] [**Room **####]:** [Surface] [Flush] Mounted. Digital. Annunciator panel shall be powered from unit storage battery and located outside of the generator room (EPS) at a location accessible and monitored by staff. Refer to drawings for location[s]. A remote, audible alarm shall be provided per NFPA110-5.6.5.2(4).

The annunciator shall have provisions for spare relay based inputs for audible/ visual alarms to meet the requirements of these specifications. Refer to Generator Source Alarm Annunciation/ Indication.

The annunciation alarm shall be capable of being silenced and the panel shall include repetitive alarm circuitry so that after the audible alarm has been silenced, it re-activates after the fault condition has been cleared.

Provide all wiring and raceway systems as required.

**Remote Emergency Stop “Mushroom” Switch:** Provide emergency shut off switch on the unit generator and one remote mounted device at location indicated on drawings.

Remote mounted devices installed outdoors shall be installed in approved wet location wiring method.

Shut off switch: Red button with (2) N.O. and (2) N.C. contact block. Switch shall be capable of lockout and tagout.

Provide label with “Emergency Shut Down”- White letters on Red background.

Provide all wiring, raceways and mounting systems as required.

**Generator Source Alarm Annunciation/Indication:** Provide audio/visual alarm indication to generator control panel and to remote annunciator panel if the generator output circuit breaker(s) and OCPD serving the emergency side of each automatic transfer switch is in the “Tripped or “Open” position. Provide monitoring micro-switches. Provide wiring diagram at equipment submittal. Green light to indicate OCPD is closed and Red light to indicate OCPD is open. One point per each OCPD. Provide all wiring, raceway and contacts as required for this function. Separation between NEC article 700, 701 and 702 wiring shall be maintained.

Provide wiring diagram at equipment submittal.

**Building Automation Alarm Interface:** Provide a “Alarm” and “Generator Run” dry contacts to be tied into the building’s automation system.

Provide alarm set point for each monitored generator output circuit breaker(s) or OCPD serving emergency side of each automatic transfer switch indicating tripped or open position.

***The consultant shall add the following two items for Combined Heat and Power- CHP units.***

[Provide an analog input for reset of the heat recovery (Jacket & Exhaust) water supply temperature generated by the generator set for heat recovery.]

[Provide a digital input for generator enable/disable.]

Provide all wiring and raceway to the building automation system control panel.

**Generator Feeder:** The ampacity of the conductors from the generator terminals to the first distribution device containing overcurrent protection shall not be less than 115% of the nameplate current rating of the generator.

***The consultant shall coordinate with DFD reviewer and generator sourced systems served by generator to determine the need for manual transfer switch to comply with NEC 700. 3 (F). MTS to be sized for full rating of generator unless prior approval from DFD electrical reviewer.***

**Connection Cabinet:** Provide stainless steel [wall] [pad] mounted NEMA 4X combination manual transfer switch- double throw switch with center off position/ connection cabinet to meet the requirements of NEC 700.3 (F). Cabinet shall contain a fused main, phase rotation meter and silver plated copper bus rated 115% of generator nameplate with mechanical set screw lugs. Indicate on one-line diagram.

***The consultant shall review the need for portable load bank with DFD electrical reviewer and user agency.***

**Load bank Connection:****[**Provide accessories internal to generator for connection of external load bank.][Provide one portable resistive load bank for project. Load bank to be three phase 60 Hz [55] [ ] KW 240/480VAC model with 5 KW load step resolution. Furnish load bank with hard cover protective transport case on casters with retractable handle. Furnish load bank with 20 ft minimum length cables capable of connecting to set of load side lugs provided on generator output bus for remote load bank.]

**PART 3 - EXECUTION**

**EXAMINATION**

Verify that required utilities are available in proper location and ready for use.

**INSTALLATION**

Install in accordance with manufacturer's instructions.

Generator set shall be anchored to concrete pad.

Coordinate with local utility gas provider for new gas service and associated regulator. Piping shall be compliant with utility company installation requirements. Shut off valve handle shall be removed and located inside generator enclosure if valve is installed exposed at generator.

Utility costs for service installation shall be separate from this work.

Generator, associated transfer switches and distribution equipment installed indoors shall be located in separate rooms from normal electrical service equipment. Rooms shall have minimum 2 hour rating. No other equipment, including architectural appurtenances, except those that serve the space shall be permitted in this room. The room housing the Generator (EPS) and the room housing the generator distribution equipment and transfer switches (EPSS) shall be ventilated to and from the exterior.

Interior and exterior Generator installations shall be provided with battery powered emergency lighting to illuminate area surrounding generator/ generator enclosure.

Generator Emergency Shutdown switch shall be located [outside interior generator room] [on exterior building adjacent to exterior generator enclosure].

***The following requirement applies to outdoor installations. The consultant shall delete the following for indoor applications.***

[Outdoor Generator Enclosure Accessory Panelboard: **The accessory** **source panel and all related branch circuitry shall be furnished and installed by the Electrical Contractor. This includes, but is not limited to, the circuiting for the battery charger, engine heater, enclosure lighting, and convenience receptacle.**]

**Feeders:**

Feeder wiring serving emergency loads shall be installed per NEC 700.10(D)(1) through (D)(3).

**Control Conductors:**

All generator control conductors installed between transfer equipment and the emergency generator serving Emergency, Legally Required Standby and Optional Standby systems shall be kept entirely independent of each other and all other wiring. **This shall require a dedicated conduit system between each transfer switch and the emergency generator**.

All Emergency branch control conductors installed between transfer equipment and the emergency generator shall be installed per NEC 700.10(D)(1) through (D)(3).

***The consultant shall review the grounding requirements of the proposed system. Review the use of 3 or 4 pole transfer switches and type of system- separately derived system or connected as equipment.***

**Grounding:**

When 4-pole transfer switches are utilized, the generator shall be installed and connected as a separately derived system and the factory installed generator ground/neutral bonding strap shall be maintained.

When 3-pole transfer switches are utilized, the generator shall be installed and connected as an equipment connection (not a separately derived system) and the factory installed generator ground/neutral bonding strap shall be removed.

**Labeling:**

Provide a sign at service entrance equipment indicating type and location of onsite emergency power sources (EPS).

Provide a sign at grounding electrode conductor when grounding connection is remote from generator. Sign shall identify location of all emergency and normal sources connected to that location.

**FIELD QUALITY CONTROL**

Operational testing of complete emergency electrical system shall be conducted prior to scheduling the required full load test to ensure complete system operation.

The State of Wisconsin DFD Electrical Inspector shall witness the performance and full load testing. The scheduling of the tests shall be **approved** by the electrical inspector prior to test commencement.

Provide full load testing utilizing a portable test bank for four hours continuous, minimum. During the first two hours, step increase the load from 0% to 100% in at least six equal steps. At the end of two hours, continue running test at 100% load. Record the following in 20 minute intervals throughout the four hour test: kilowatts, amperes, voltage, coolant temperature, room temperature, generator frequency (Hz), oil pressure, fuel consumption.

***The consultant shall delete the following outside temperature requirement if Natural Gas is the specified fuel. The requirement only pertains to LP onsite stored fuel.***

Full load testing utilizing a portable test bank shall be conducted with minimum outside temperature of 32 degrees F.

After the generator has cooled down from the four hour test, shut it down and simulate a power failure including operation of the transfer switch, automatic start up, shutdown and return to normal.

**CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

**FUNCTIONAL PERFORMANCE TESTING**

Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 26 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01 or 01 91 02.

# AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01, or 01 91 02.

END OF SECTION